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ON SOME LEECH-LIKE PARASITES OF AMERICAN CRAYFISHES.

BY J. PERCY MOORE.

In 1851 Dr. Leidy described in the Proceedings of this Academy the external characters of *Astacodella philadelphica*, which he found occupying generally the exterior of *Cambarus bartonii*. This account was quoted in full in the Synopsis of American Freshwater Leeches published in 1874 by Verrill, who adds no observations of his own. Other than these the writer is acquainted with no published accounts of American Discodrilidæ (Vejdovsky). Attracted by the peculiar structure, the uncertain affinities, and most of all, by the remarkable variability of these parasites, a score of zoologists have been led to contribute to our knowledge of the European forms. The question of the specific distinctness or unity of the several forms which take up their abode on *Astacus fluviatilis* has led to considerable discussion, which has not yet reached a definite settlement. Vejdovsky believes the three or four forms which have been described as distinct species to be but varieties of one extremely variable species—a view to which a strong support is lent by the elaborate tables of variations prepared by Voigt. Whitman has found living on the crayfishes of Japan a similar multiplicity of forms, which have been regarded as constituting three distinct species, but which have not, the writer believes, been described.

It now appears that our American crayfishes likewise carry about with them a heterogeneous burden of leech-like parasites (or mess-mates?). Our common *Cambarus bartonii*, for example, is affected by at least four forms, which are easily distinguished, and which will be here described as specifically distinct. Other and different forms have been found by the writer on *C. affinis* and on *C. ———* which inhabits the larger mountain streams of western North Carolina. These being the facts, the writer thought it well to present for publication the present short account, which is entirely preliminary to a more complete discussion of the structure and affinities of these Annulata, the first instalment of which will soon appear. It is hoped that this paper will serve to direct the attention of zoologists to this neglected

group, and lead to the collection of the numerous forms which it seems reasonable to suppose must attach themselves to the bodies of our many species of crayfish. The monographic study of such a group as this would doubtless furnish us with data of great value in the consideration of our theories of variation. The writer would be especially indebted to anyone who will kindly furnish him with material collected in other localities or from other species of crayfish.

Regarding the specific distinctness of the forms here described it may be said that the writer has examined several hundred specimens ranging in size and age from individuals just emerged from the cocoon to those of the largest dimensions, and while each species exhibits a considerable range of variation (which will form the subject matter of a subsequent paper), no important transitional forms have been discovered, the diagnostic characters here given being maintained with as much constancy as is usual amongst closely allied animal species.

Even should the views of Vejdovsky and Voigt prove to be correct for the European species, which seems probable, this would in no way affect the status of the American forms; for other cases are not wanting where a group of animals which in one region is represented by a single variable species, in another has numerous specific representatives. This would then be only another fact in support of the view, now almost universally conceded, that species are but more widely separated varieties, which under the stress of changing conditions have continued to diverge from a common origin. Indeed, it is not certain that these species should be placed in the same genus even, for they are distinguished from one another by anatomical characters of such importance as would, in some groups of animals, rank of generic value. The several species are here referred to the single genus *Branchiobdella* chiefly because the writer is uncertain as to the legitimate limits of a genus in zoology, and because in this preliminary paper it is sufficient to recognize the existence of distinct forms without attempting to fix the exact conventional value of the gap which separates them—a labor which belongs more rightly to the systematist, whose work of sorting and arranging would be quite premature in a group of which only a very small portion of the probable number of existing species have been examined. Moreover it should be borne in mind that much confusion has resulted from the unnecessary multiplication of genera.

The four species of *Branchiobdella* here considered agree with one another, and differ from the European species (*B. varians* of Voigt = *B. astaci* Odier, + *parasita* Braun, + *pentodonta* Whitman, + *herodonta* Gruber) in the possession of two pairs of vasa deferentia, in the fifth and sixth post-cephalic segments; while *B. variens*, as described by Dorner, whose account I have not seen corrected, has but one pair.

Our four species group themselves somewhat naturally in pairs. *B. philadelphica* and *B. illuminata* agree in the terete cross-section of the body, the posteriorly directed posterior sucker, the common external opening by means of a vesicle (which is pulsatile in *B. philadelphica*, at least) of the anterior pair of nephridia, and the unlike form of the dorsal and ventral jaws. *B. pulcherrima* and *B. instabilia* agree in having the body depressed and more or less laterally expanded posteriorly, in the ventral direction of the face of the sucker, the distinct external openings of the anterior two nephridia, and the similar dorsal and ventral jaws. The second group is much more closely allied to the European forms.

***Branchiobdella illuminata*, sp. nov.**

Fig. 1*a*., Plate XII, external outline of the animal of its usual resting form, showing also the outline of the alimentary canal, the principal trunks of the vascular system, the series of clear glands of the right side, and the common nephridial vesicle opening to the exterior on the dorsum of the third post-cephalic segment, x23, drawn from a living specimen. Fig. 1*b*, the two jaws in normal relative positions, x400. Fig. 1*c*, outline of a cocoon, x45.

This species has been named *illuminata* in allusion to the double series of clear glands which in mounted specimens viewed by transmitted light appear like rows of pale-lighted lamps.

Body very slender in complete extension, but robust in contraction, tapering from the seventh segment very gently toward the head, and suddenly to the posterior sucker; terete in transverse section in all regions. Bi-annulation of segments very conspicuous throughout the entire length. Posterior sucker small and weak, on the same axis as the body segment. Head small, slender, and elongated; the post-oral part distinctly bi-annulate. Lips long and weak, of nearly equal size; ridged within by longitudinal folds. Mouth opening with its longest diameter transverse. No circumoral or other hairs have been detected in the adults of this species; and in the young a

single small bunch in the median region of each lip is all that is present.

The jaws are remarkable, and although large, are inconspicuous on account of their transparency and lack of color. On the dorsal one, which is much the larger, a high median ridge is developed, which bears three strong teeth, the points of which are directed posteriorly (down the throat). The ventral jaw is shaped like a U each limb of which is bent out of the common plane into a boomerang shape. The angle of the boomerang on each side is uppermost and bears a very strong curved tooth, the two bounding a deep groove which accommodates the dorsal dentigerous ridge.

The stomach is comparatively small, and behind it the evenly tubular intestine is thrown into loops, which become more obvious with the greater degree of contraction of the animal.

In connection with the vascular system is developed a remarkable shallow sinus which covers almost the entire surface of the alimentary canal. This presents dorsal and ventral longitudinal enlargements into which the principal vascular trunks are received. The extensive vascular surface with the contained bright red blood thus presented gives the animals a delicate pinkish hue which distinguishes living individuals at a glance from the other species herein described.

In each of the nine post-cephalic segments is a pair of peculiar translucent glandular bodies composed of large nucleated cells, and communicating with the exterior by slender ducts having ventro-lateral openings.

The anterior two nephridia open into a gourd-shaped vesicle having an opening to the exterior in the mid-dorsal region of the major annulus of the third segment. The spermatheca is short, cylindrical and bifid; the penis-sac short-pediced and spherical, and the atrium clavate and curved. The spermatheca, penis, ovaries, posterior paired nephridia and anus open respectively on the fifth, sixth, seventh, eighth and ninth post-cephalic segments. Length of full grown individuals, 4 mm., maximum diameter (7th segment) .9 mm., diameter of acetabulum .35 mm. The figure represents an individual of maximum size.

The cocoon is regularly ellipsoidal in shape and bears an anchoring pedicle at each pole of the major axis. Length of cocoon, .55 mm., diameter, .40 mm., length of pedicles, .33 mm.

This species is very common and has been found in the branchial

chamber of nearly one-half of the larger individuals of *C. bartonii* that I have examined. It appears never to leave the branchial chamber during the life of the crayfish, except at the time of moult. The cocoons are found throughout the year attached to the branchial filaments, especially the inner ones. Philadelphia, Pa. and Watauga Co., North Carolina.

***B. pulcherrima*, sp. nov.**

Fig. 2*a*, Plate XII, outline of the entire animal as seen from the side, showing the adhesive organs on the eighth and ninth segments, x23. Fig. 2*b*, the same specimen from the dorsal aspect, with an outline of the alimentary canal, x23. These drawings are from a medium sized preserved specimen. Fig. 2*c*, one of the jaws of the usual form, x200. Fig. 2*e*, a cocoon, x45.

The beautiful transparency of the anterior segments, which enables one to see with great distinctness the internal organs of that region suggested the name given to this species.

Form rather stout, the body depressed, especially in the posterior region. The segments increase regularly in width to the seventh, which is the broadest; and behind which they rapidly narrow to the acetabulum. Each post-cephalic segment consists of an anterior larger and a posterior smaller annulus. The ventral surfaces of the eighth and ninth segments are strongly flattened, and each bears on its extreme lateral margins a cup-shaped adhesive organ, into the central depression of which a conspicuous gland opens. These are directed ventralward and doubtless serve as accessory organs of attachment to aid the rather weak sucker. Those on the eighth segment are usually the larger, but a considerable range of variation is exhibited in this respect. The structures become proportionally larger and more conspicuous in older individuals.

The head is urn-shaped, slightly longer than broad in preserved specimens, and its greatest width less than or just equal to that of the first body segment. The breadth of the head varies greatly with the degree of contraction of the specimen, but in the living individual always appears narrow, and to form part of the generally even tapering outlines of the body, never abruptly expanded as in *B. instabilis*. The oral region is separated from the cephalic region by a deep constriction, which completely encircles the head. The mouth is enveloped by a pair (dorsal and ventral) of distinct thick

muscular lips, of which the dorsal one is the larger and droops downward, partially enclosing the ventral lip. Each presents a slight median emargination, but is otherwise entire. The lips and head, as well as the sides of the principal annuli of the body, are provided with a fringe of delicate hairs. Mouth opening nearly circular, between the parted lips.

The jaws are small and inconspicuous, in adult specimens less than one-twelfth of the width of the head, and of a pale brown or amber color. The rounded base bears three teeth, of which the larger lateral ones are stout, curved, and divergent, while the smaller median one is straight and sharp-pointed. The variations in the jaws involve frequent unsymmetrical development of the teeth. The dorsal and ventral jaws are similar, and both are fixed opposite to the constriction behind the lips, the teeth being directed inward.

The straight alimentary canal is strongly sacculated in the second, third and fourth segments, behind which it is narrow, and direct in its course to the anus, which opens on a slight papilla on the dorsal side of the ninth segment.

The greater part of the body cavity of the fifth and sixth segments is filled with testicular cells in various stages of development; and the glandular thickening of the skin of these segments renders the walls conspicuously opaque. The two pairs of vasa deferentia open into the nearly spherical atrium in the sixth segment. A conspicuous and broadly pyriform spermatheca opens on the fifth segment. The ovaries and accessory structures occupy the seventh. The anterior nephridia alternate in position, but open to the exterior by paired orifices in segment three. The posterior paired nephridia occupy the space on each side of the intestine in segment eight.

This species is colorless and more or less translucent; the first four segments behind the head are remarkably clear and translucent, but behind this the body walls are rather opaque and the position of the internal organs obscured. The alimentary canal is throughout darkly colored, except within the head.

Blood very pale red.

Length of mature individuals	6 mm.
Maximum breadth	1.3 "
Width of jaws06 "
Diameter of acetabulum6 "

Cocoons of this species are almost spherical and are borne on short stout stalks. Usually they are attached to the broad surfaces of the body, *i. e.*, the sides of the carapace, inner faces of the anterior abdominal epimera, and the sternal face of the tail fin.

Length of cocoon without stalk 46 mm.

The adults are found attached almost anywhere on the exterior of the crayfish but more especially on the tergal surface.

Watauga Co. North Carolina, on *Cambarus bartonii*.

B. instabilia, sp. nov.

Fig. 3*a*, Plate XII, an unusually large individual seen from the ventral side, showing the outlines of body and alimentary canal. Drawn from a living individual in nearly full extension, x25.

Fig. 3*b*, and 3*c*, two views of the jaws, x200.

Fig. 3*e*, a cocoon, x45.

The constant movements of the lips, and the varying form of the head and segments succeeding it during the life of the animal make the name *instabilia*, the changeable, most appropriate.

Body in a state of contraction very short and stout, the posterior four segments forming a flattened disk-shaped expansion which is scarcely longer than broad; the first four body segments are much more narrow, but increase somewhat in breadth to the fourth, posterior to which the increase is very rapid to the seventh; the eighth is slightly narrower and develops lateral wing-like flaps, which, sloping ventralward, bound a decided ventral concavity in this region; posteriorly they embrace the sucker-bearing segments. The head and anterior segments are terete. Under normal conditions the large head is considerably broader than the following segments, which form a neck-like constriction, to which the head is attached by a very mobile fold, forming a distinct annulus. The emarginated lips are slightly crenulated, and form an almost continuous muscular thickening around the mouth. The post-oral constriction is well marked, but not so deep as in *B. pulcherrima*. Numerous short stiff hairs fringe the lips and head, and in young individuals are present on the body segments also.

The dark brown jaws are provided with four strong, curved, conical teeth, which diverge slightly; the outer pair are symmetrical, the left tooth of the middle pair is much larger than the right; this

being the case in both jaws in nearly all of the many specimens examined.

The acetabulum resembles that of *B. pulcherrima* in being directed ventralward. Its diameter is greater than that of the first or second body segments. Bi-annulation is conspicuous on the anterior four post-cephalic segments only.

The alimentary canal is strongly sacculated in the fourth and fifth segments, in the sixth is pushed to the left side by the development of the atrium (this occurs in adults only), in the seventh is thrown into a complete double transverse loop which passes first to the right and then to the left, and finally passes directly to the anus in the ninth body segment. The spermatheca is very small and inconspicuous, while the penis-sac is well developed, and possesses a long vermiform appendage (atrium) which forms a loop dorsally over and around the intestine. Sexual and nephridial openings as in *B. pulcherrima*.

In contraction the body of this species is shaped like a short-handled raquet; in extension it has the outline of an Indian club from dorsal and ventral views.

Length of mature animal	5.5 mm.
Maximum breadth,	1.3 "
Diameter of acetabulum5 "
Transverse diameter of jaw048 "
Length of cocoon without pedicle35 "

The cocoons resemble those of the last described species, but are frequently provided with an apical fibrous tuft. They are invariably attached (to the extent of my experience) to the palmar surface of the propodite of the great chelæ. The animals themselves are largely restricted in their distribution to the same segments of the limb, and are usually to be found in numbers clustered at the base of the pincers to which position the form of the body peculiarly adapts them; for while the constricted anterior region, by reason of its tenuity, easily escapes crushing between the closing limbs of the chela, in which position it is frequently liable to be caught, the important organs of reproduction and digestion are massed together near the base of attachment, entirely out of reach of danger from this source. Frequently they wander to other parts of the same pair of limbs, or even to the two pairs of ambulatory limbs following.

Watauga Co., North Carolina, and by Mr. P. P. Calvert in Delaware Co., Penna.

B. philadelphia Leidy. *Astacobdella philadelphia* Leidy, Pro. Acad. Nat. Sci. Phila., 1851, p. 209, Verrill, Rep. U. S. Com. Fisheries for 1872-73, p. 688.

Fig. 4*a*, Plate XII, shows the external outlines of the body, and the alimentary canal of a moderately sized living adult, x23. Figs. 4*b* and *c* represents the dorsal, and 4*d* the ventral jaw, x100. Fig. 4*e*, cocoon, x45.

Dr. Leidy's description is here reproduced "Body whitish, translucent; sides nearly parallel, a little broader posteriorly, sixteen alternately broad and narrow segments exclusive of head and posterior end. Head campanulate, terminated by a circular or elliptical crenated lip, fringed with very minute stiff hairs, one two-thousandth of an inch long. Acetabulum circular, one-sixth or one-fourth of a line in diameter; mouth elliptical. Dental plates brown, nearly equal, forming an isosceles triangle, with the base longest and attached apex of superior plate ending in a sharp conical point; with several very minute denticulations on each side, apex of inferior plate bifurcated into two points, with two minute denticulations on each side. Stomach capacious, nearly filling the anterior eight alternately broad and narrow segments posterior to the head. Anus dorsal, one-fifth of a line from the acetabulum. Generative opening ventral, anterior to the anal aperture. Length, one to four lines; breadth, one-sixth to one-half of a line. Head, one-sixth to one-half of a line long. Ovum attached by a pedicle, with an operculum pointed at summit. From base of attachment to point of opercle, one-fifth of a line. Length of body of ovum, one-sixth of a line; breadth, one-eighth of a line.

"Habitat.—Found frequently in numbers from one to several dozen upon any part of the exterior of the body of *Astacus bartonii* Fab., but more especially upon the inferior surface and the branchiæ."

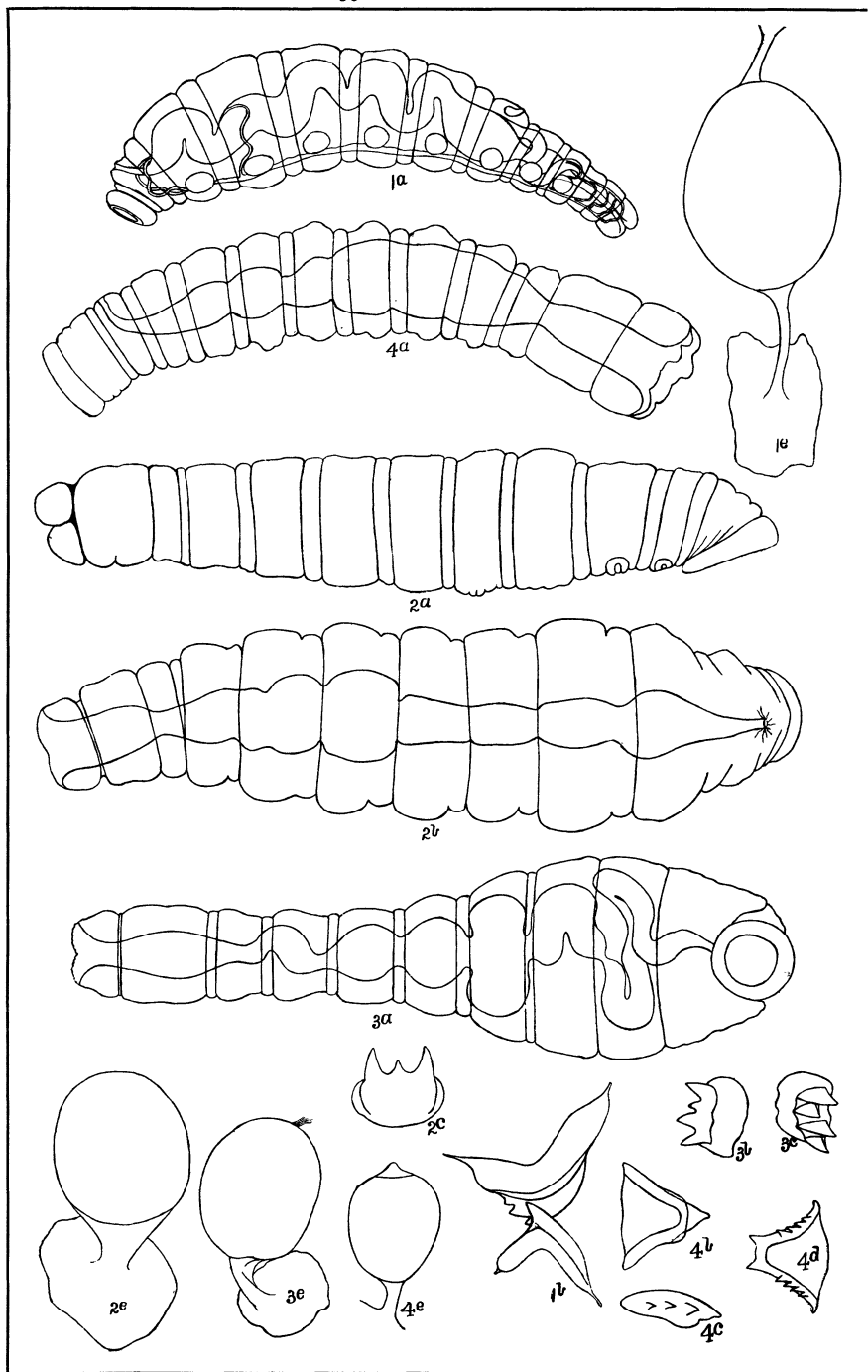
The spermatheca is large, short-cylindrical, and curved; and the penis-sac is cylindrical and possesses prominent atrial appendage. The external openings of these and the ovaries are as usual. The anterior nephridia terminate in very large transverse tubes which open into a pulsatile vesicles situated in the third segment. The other anatomical characters are in no way remarkable.

I have never found this species inhabiting the branchial chamber,

but principally the sternal surface of the entire body, among the bases of the appendages. The cocoons are attached to the abdominal sternites, but more frequently to the setæ of the pleopods. They are to be found principally in summer, but are not entirely absent at any season.

Phila. Pa., and Watauga Co., North Carolina.

The author has, since writing the above, examined a preparation of *B. parasita* Braun, in which he was able to distinguish only a single unpaired vas deferens. Compare Vejdovsky, Systemu Monographie der Oligochæten.



MOORE: PARASITES OF CRAYFISHES.